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Vol. III JANUARY, 1916 No. 1

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PROCEEDINGS

A REGULAR meeting of the Boston Society of Civil Engineers will be held on

WEDNESDAY, JANUARY 26, 1916,

at 7.45 o'clock P.M., in CHIPMAN HALL, TREMONT TEMPLE, BOSTON.

Mr. W. R. Farrington, Division Engineer of the Massachusetts Highway Commission, will read a paper on "Sand and Oil Roads and Surfaces."

S. E. TINKHAM, *Secretary.*

PAPERS IN THIS NUMBER.

"The Water Supply of Salem, Mass.," W. S. Johnson.

"Early Types of Turbines," C. W. Sherman.

"Joint Mortar Exposed to Tidal Currents," J. L. Howard.

Discussion of "Special Methods of Reinforced Concrete Design."

Memoirs of deceased members.

CURRENT DISCUSSIONS.

Paper.	Author.	Published.	Discussion Closes.
"South End Sewer System, Boston."	E. S. Dorr.	Dec.	Feb. 10.

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Contributors are hereby notified that proof will not be submitted to them for examination unless requested before the 10th of the month preceding the month of publication.

MINUTES OF MEETINGS.

Boston, Mass., December 15, 1915.—A regular meeting of the Boston Society of Civil Engineers was held this evening at Chipman Hall, Tremont Temple. The meeting was preceded by a dinner, served in the same hall at 6 o'clock, at which 118 members and ladies participated, dinner being followed by a short entertainment.

The business meeting was called to order at 8 o'clock by the President, Charles R. Gow. The total attendance of members and guests, including ladies, was 180.

By vote, the reading of the record of the November meeting was dispensed with and it was approved as printed in the December Journal.

The Secretary reported for the Board of Government the election of the following to membership in the grades named:

Members — Lyman Waldo Bigelow, Nathan Carter Burrill, William Haskins Coburn, John Dana Savage and Charles Norton Taylor.

Juniors — Horatio Whittemore Brown, Joseph Richard Duggan, Gordon Fehr, Howard Leslie Foster, Howard Whipple Green, Frank Bowman Hastie, Thos. Francis McSweeney, John Wm. Shorrock and Ellis Spence Tisdale.

The Secretary announced the death of J. Herbert Shedd, a member of the Society, which occurred November 27, 1915, and by vote the President was requested to appoint a committee to prepare a memoir.

The President then introduced Mr. A. A. Cohill, civil engineer, who read a paper entitled, "The Construction of the Dorchester Tunnel under Fort Point Channel." The paper was illustrated with lantern slides and motion pictures, the latter being furnished by P. McGovern & Co., the contractors for building the tunnel.

After extending a vote of thanks to Mr. Cohill for his kindness in presenting the paper before the Society in such an interesting manner, the meeting was adjourned.

S. E. Tinkham, *Secretary.*

Boston, Mass., November 24, 1915. — A special meeting of the Sanitary Section, Boston Society of Civil Engineers, was held this evening in the Society Library. The meeting was called to order at 8 o'clock by the chairman.

The minutes of the November 3d meeting were read and approved.

The chairman then introduced Mr. Harold I. Eaton, chief inspector, Atlantic County, N. J., Mosquito Extermination Commission, who gave a very interesting account of mosquito extermination work in Cuba, Panama and New Jersey. A large number of slides were used to illustrate methods and apparatus. The plan of organization adopted in Atlantic County was described and copies of reports and inspection blanks shown.

The subject was discussed by a number of gentlemen and many questions were asked, indicating considerable interest in this subject.

It was voted to extend to Mr. Eaton the thanks of the Section for his courtesy in presenting the paper of the evening.

In the audience were a number of city officials outside the membership of the Society.

There were 54 present.

Adjourned at 10 o'clock.

Frank A. Marston, *Clerk.*

Boston, Mass., December 1, 1915. — A regular meeting of the Sanitary Section, Boston Society of Civil Engineers, was held this evening in Myers Hall, Tremont Temple.

At 6 o'clock a supper was served (buffet style) in the Society library. There were 90 present.

The meeting in Myers Hall was opened at 7.30 o'clock by the chairman. The minutes of the November 24th meeting were read and approved.

The speaker of the evening was Mr. Frederic H. Fay, past president of the Boston Society of Civil Engineers, who gave an illustrated talk on the "Proposed Improvements of the Quequechan River, Fall River, Mass." The problems presented were of an unusual and interesting character. There was some discussion following the talk, and many questions were asked of the speaker.

There were 113 present.

Adjourned at 9 o'clock.

FRANK A. MARSTON, *Clerk.*

APPLICATIONS FOR MEMBERSHIP.

[January 6, 1916.]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

BABBITT, JOHN HANCOCK, Cambridge, Mass. (Age 21, b. Northampton, Mass.) Junior at Mass. Inst. of Technology, civil engineering course; attended Mass. Inst. of Technology Surveying Camp during one summer. Refers to C. B. Breed, G. L. Hosmer, J. W. Howard, A. G. Robbins, G. E. Russell and C. M. Spofford.

CROCKER, HENRY LOVELL, Boston, Mass. (Age 26, b. Yorktown, N. D.) Received technical education at Lowell Inst., mechanical engineering course, and at Franklin Union, course in reinforced concrete and bridge design. From 1908 to 1911, transitman with Aspinwall & Lincoln, Boston; from 1911 to date, assistant with Boston Transit Commission. Elected a junior, September 18, 1912, and now desires to be transferred to grade of member. Refers to E. S. Davis, F. C. H. Eichorn, G. D. Emerson, J. B. Flaws, J. T. Frame and L. B. Manley.

Kleinert, Albert Emanual, Jr., Boston, Mass. (Age 24, b. Brooklyn, N. Y.) Student at Mass. Inst. of Technology, class of 1915. Refers to C. F. Allen, C. B. Breed, H. J. Hughes and L. J. Johnson.

Maynard, Forrest Joseph, Watertown, Mass. (Age 31, b. Lancaster, Mass.) High school education. From 1902 to 1904, with Parker & Bateman, Clinton, Mass.; from 1905 to 1912, with exception of eighteen months on bridge and railway work in West, was assistant engineer on railway surveys and construction in Panama for United Fruit Co.; from 1912 to 1914, in private practice as engineer and surveyor, Watertown, Mass.; since August, 1914, with Edison Co., Boston, St. Engrg. Dept. Refers to F. C. H. Eichorn, J. T. Frame, J. F. A. Giblin, E. L. Johnson and O. F. Mann.

Parker, Robert Emerson, Reading, Mass. (Age 27, b. Reading, Mass.) Graduate of Dartmouth College, 1910, and of Thayer School of Civil Engineering, 1911. From May to Sept., 1910, designer with Boston Elevated Ry. Co., Central Sq. office, Cambridge; from May, 1911, to date, draftsman and designer with Aberthaw Construction Co., Boston; is also inspector of buildings, Reading, Mass. Elected a junior, Jan. 24, 1912, and now desires to be transferred to grade of member. Refers to W. H. Balch, M. F. Brown, J. A. Garrod, A. B. MacMillan and H. F. Sawtelle.

Smith, William Henry, Dedham, Mass. (Age 20, b. Boston, Mass.) Graduate of Mass. Inst. of Technology, 1915, civil engineering course. During summers of 1913 and 1914, and from graduation to date, rodman, draftsman, transitman, etc., with E. Worthington, Dedham. Refers to C. F. Allen, C. B. Breed, J. W. Howard, C. M. Spofford and Erastus Worthington.

LIST OF MEMBERS.

ADDITIONS.

Atwood, Thomas C.	185 Church St., New Haven, Conn.
Barney, Harold B.	18 Spooner Rd., Chestnut Hill, Mass.
Brown, H. Whittemore	Mass. Inst. of Technology, Boston, Mass.
Burrill, Nathan C.	88 Broad St., Boston, Mass.
Colby, Edwin W.	4 St. Botolph St., Boston, Mass.
Fehr, Gordon	11 Irvington St., Suite 2, Boston, Mass.
Foster, Howard L.	3 Greenwood St., Amesbury, Mass.
Green, Howard W.	11 Irvington St., Boston, Mass.
Savage, John Dana	150 Prichard St., Fitchburg, Mass.
Shorrock, John W.	39 Longfellow St., Dorchester, Mass.
Taylor, Charles N.	12 Grove St., Wellesley, Mass.
Tisdale, Ellis S.	Mass. Inst. of Technology, Boston, Mass.
Wadsworth, George R.	37 Philbrick Rd., Brookline, Mass.
Walker, Frank B.	86 Bartlett Rd., Winthrop, Mass.

CHANGES OF ADDRESS.

Ambler, Halford H.	Hotel Clayton, Detroit, Mich.
Bessey, Roy F.	3109 Clarendon Rd., Brooklyn, N. Y.
Milne, Alexander P.	321 Platt Bldg., Portland, Ore.
Van Rensselaer, Allen	General Delivery, San Francisco, Cal.
Whiting, Mason T.	201 Devonshire St., Boston, Mass.

DEATHS.

Ellsworth, Emory A.	December 8, 1915
Richardson, Thomas F.	December 26, 1915
Shedd, J. Herbert	November 27, 1915

EMPLOYMENT BUREAU.

The Board of Government maintains an employment bureau for the Society, to be a medium for securing positions for its members and applicants for membership, and also for furnishing employees to members and others desiring men capable of filling responsible positions.

At the Society room two lists are kept on file, one of *positions available* and the other of *men available*, giving in each case detailed information in relation thereto.

Men Available.

338. Age 22. Graduate of the University of Maine, 1915, with degree of B.S. in civil engineering. Has had six months' experience as detail draftsman on machine parts and factory lay-outs. Desires position as structural draftsman. Salary desired, $18 per week.

339. Age 29. Graduate of Harvard, 1908, with degree of A.B.; received degree of S.B. in civil engineering, 1909. Has had four years' experience as draftsman, estimator, division engineer, etc., on hydro-electric construction; and one year and a half as timekeeper and cashier on paving contracts. Desires position along engineering lines with good chance for advancement. Minimum salary desired, $100 per month.

340. Age 24. Graduate of Worcester Polytechnic Inst., 1914, civil engineering course. Has had one year's experience as instrumentman, including field and office work, with Met. Water Works; six months as transitman on preliminary surveys for highway construction; and one month as draftsman on general building construction with firm of mill engineers and architects.

341. Age 31. Graduate of Mass. Inst. of Technology, civil engineering course, 1905. Has had about ten years' experience, including two years as instrumentman and chief of party on surveys for water-power and flood-prevention projects; five years as designer for water supply, gas and electricity boards; and one and one-half years, to date, on construction of filtration plant. Desires position along hydraulic or sanitary engineering lines. Minimum salary desired, $1,500 per year.

342. Age 28. Graduate of Dartmouth College, with degree of B.S., 1909; senior year in Thayer School of Civil Engineering. Has had about six years' experience as rodman, instrumentman, chief of party, draftsman and assistant engineer on dam construction, boundary surveys, harbor improvements and construction of sewage filtration beds. Desires position as assistant engineer or chief of party upon water supply, sewage disposal, general construction or general surveying work. Salary desired, $125 per month.

343. Age 25. Student for three years at Purdue University, civil engineering course. Has had nearly three years' experience, including two years as draftsman, instrumentman, etc., on railway work; and nine months as foreman and assistant superintendent on water-works construction. Desires position as engineer (field or office work) or as assistant superintendent on construction. Salary desired, $90 per month.

LIBRARY NOTES.

BOOK REVIEW.

General Specifications for Concrete Work as Applied to Building Construction. Reviewed by A. B. MacMillan.*

This is the second edition, revised and enlarged, of a work that originally appeared in 1908.

It consists of fifty-six pages about eight and one-half by eleven inches in size. Four pages are given up to title, preface and index, twenty-eight pages to specifications, and twenty-four pages to designing data and tables.

The specifications cover the general subject of concrete, aggregate, proportioning, mixing and placing, finish, protection, forms, reinforcement, etc. Some space is devoted to cast stone, concrete piles and waterproofing.

The formulæ given are the usual straight line formulæ for single rectangular beams, tee beams and beams with compression steel. Methods of design for flat slab floors, based on the rulings adopted by the city of Chicago, are included.

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* Chief Engineer, Aberthaw Construction Co.

In general the pamphlet deals with the various subjects taken up clearly, tersely and reasonably, and should be useful to any one who has to write specification for concrete work.

RECENT ADDITIONS TO THE LIBRARY.

U. S. Government Reports.

Annual Report of Director of Office of Public Roads for 1914–15.

Annual Report of Governor of Panama Canal for 1914–15, with Maps and Diagrams.

Anticlines in Clinton Sand near Wooster, Wayne County, Ohio. C. A. Bonine.

Production of Bauxite and Aluminum in 1914. W. C. Phalen.

Bibliography of North American Geology for 1914, with Subject Index. John M. Nickles.

Cement Industry in United States in 1914. Ernest F. Burchard.

Some Cinnabar Deposits in Western Nevada. Adolph Knopf.

Cotton Production and Distribution, 1914–15.

Duncan Gas Field, Stephens County, Oklahoma. Carroll H. Wegemann.

Fauna of So-Called Boone Chert, near Batesville, Arkansas. George H. Girty.

Fauna of Boone Limestone at St. Joe, Arkansas. George H. Girty.

Field Apparatus for Determining Ash in Coal. C. E. Lesher.

Fractional Precipitation of Some Ore-Forming Compounds at Moderate Temperatures. Roger C. Wells.

Geology and Oil Resources of West Border of San Joaquin Valley North of Coalinga, California. Robert Anderson and Robert W. Pack.

Gold Deposits near Quartzsite, Arizona. Edward L. Jones, Jr.

Gold, Silver and Copper in Alaska in 1914. Alfred H. Brooks.

Gold, Silver, Copper and Lead in South Dakota and Wyoming in 1914. Charles W. Henderson.

Gold, Silver, Copper, Lead and Zinc in Eastern States in 1914. J. R. Dunlop.

Gold, Silver, Copper, Lead and Zinc in New Mexico and Texas in 1914. Charles W. Henderson.

Production of Graphite in 1914. Edson S. Bastin.

Healdton Oil Field, Carter County, Oklahoma. C. H. Wegemann and K. C. Heald.

Lawton Oil and Gas Field, Oklahoma. Carroll H. Wegemann and Ralph W. Howell.

Production of Lime in 1914. G. F. Loughlin.

Loco Gas Field, Stephens and Jefferson Counties, Oklahoma. Carroll H. Wegemann.

Latitude Observations with Photographic Zenith Tube at Gaithersburg, Md. Frank E. Ross.

Production of Manganese and Manganiferous Ores in 1914. D. F. Hewett.

Mineral Resources of Alaska. Alfred H. Brooks.

Production of Mineral Waters in 1914. R. B. Dole.

Notes on Use of Low-Grade Fuel in Europe. R. H. Fernald.

Possibilities of Oil in Porcupine Dome, Rosebud County, Montana. C. F. Bowen.

Reconnaissance for Oil near Quanah, Hardeman County, Texas. Carroll H. Wegemann.

Orofino Coal Field, Idaho. Charles T. Lupton.

Reconnaissance in Palo Pinto County, Texas, with Special Reference to Oil and Gas. Carroll H. Wegemann.

Phosphate Deposits of Florida. George Charlton Matson.

Potash Salts: Summary for 1913. W. C. Phalen.

Quicksilver in 1914. H. D. McCaskey.

Production of Salt, Bromine and Calcium Chloride in 1914. W. C. Phalen.

Production of Sand and Gravel in 1914. G. F. Loughlin.

Results of Spirit Leveling in Arizona, 1899 to 1915, inclusive. R. B. Marshall.

Results of Spirit Leveling in Missouri, 1896 to 1914, inclusive. R. B. Marshall.

Uniform Accounts for Systems of Water Supply, 1911.

Water-Supply Papers 332-B, 340-L, 352, 362-C, 375-E and F.

State Reports.

Maine. Annual Reports of Water Storage Commission for 1910–13.

New Hampshire. Annual and Statistical Report of Public Service Commission for 1913–14.

New York. Annual Report of Public Service Commission for First District for 1913: Vols. III–V.

Municipal Reports.

Baltimore, Md. Report of Topographical Survey Commission for 1910.

Chicago, Ill. Annual Report of Department of Public Works for 1913.

Miscellaneous.

American Railway Master Mechanics' Association: Proceedings for 1905–12 and for 1914. Gift of Fred M. Twombly.

American Sewerage Practice, Vol. III: Disposal of Sewage. Leonard Metcalf and Harrison P. Eddy. Gift of the authors.

Association of American Portland Cement Manufacturers: Concrete House and Its Construction; Concrete in the Country; Concrete School Houses; Concrete Silos; Concrete Surface Finish; Concrete Tanks; Concreting in Winter; Factories and Warehouses of Concrete; Manual Training Course in Concrete; Portland Cement Stucco; Reinforced Concrete Chimneys; Reinforced Concrete Poles; Standard Methods of Testing and Specifications for Cement.

Engineering Index for 1915.

The attention of members is called to the fact that among the books bequeathed to the Society by the late Edmund K. Turner is a copy of Emerson's "Hydro-Dynamics." Members will perhaps recall that some time ago your Committee asked for information as to where a copy of this book might be obtained.

One of our members has suggested that the annual reports of the Wisconsin Railroad Commission be added to the library. The Commission has supplied us with the fourth, fifth, sixth and seventh reports, for the years 1910 to 1913, inclusive. Information as to where the remaining reports can be obtained would be appreciated.

LIBRARY COMMITTEE.

NEW ENGINEERING WORK.

(Under this head a brief description of new engineering work contemplated or under construction will be presented each month. Engineers and contractors are requested to send descriptions of their work to the Secretary, 715 Tremont Temple, Boston, before 1st ol each month.)

United States Government. — NAVY DEPARTMENT. — *Navy Yard, Boston.* — The construction of a steel and concrete fireproof floor in pattern shop, Building No. 42.

Commonwealth of Massachusetts.—METROPOLITAN WATER AND SEWERAGE BOARD. — *Water Works.*

Bellevue Reservoir. — The construction of the masonry tower on Bellevue Hill in West Roxbury is completed, with the exception of the roof, work on which is in progress during favorable weather.

Pipe Lines.—The work of laying the 60-in. Weston aqueduct supply mains in Commonwealth Avenue, Newton, has been completed.

Sudbury Power Plant.— The work of constructing the surge tanks and preparing the foundations and wheel pits for the hydroelectric plant at Sudbury Dam in Southborough has been completed. The plant which is to be installed includes three vertical shaft hydraulic turbines directly connected to one 900 K.V.A. and two 275 K.V.A., A. C. generators. The work of erecting the machinery will be in progress the latter part of the month.

Sewerage Works. — Work is in progress on Sect. 106, the Wellesley extension sewer; on Sect. 1A, the outfall sewer at Deer Island, and on Sect. 19, the Malden River Siphon.

Work contemplated includes Sections 103 and 104, Wellesley extension sewer, for which contracts have been awarded and on which work will soon be started; and Sect. 1, Deer Island outfall, contract for which will be prepared in order to start work in the spring.

METROPOLITAN PARK COMMISSION. — The following work is in progress:

Charles River Reservation. — The work of building reinforced concrete bridge over the Charles River at North Beacon St., Boston and Watertown, has been begun. A. G. Tomasello, contractor.

Plans are being prepared for bridge over the Charles River at Commonwealth Ave., between Newton and Weston, and bids will be asked for the work before spring.

Work of excavating channel of Charles River from Elm St. to Bleachery Dam, Waltham, is in progress. John R. Burke, contractor.

Furnace Brook Parkway. — Work of construction of parkway extension from Quincy Shore Reservation to Hancock St. is in progress. John Cashman & Sons Co., contractor.

Work of building reinforced concrete girder bridge across Blacks Creek, for Furnace Brook Parkway Extension, is in progress. Hugh Nawn Contracting Co., contractor.

Mystic Valley Parkway. — Work of excavating the channel of Aberjona River from Boston & Maine Railroad Bridge to Waterfield St. is in progress. Coleman Brothers, contractors.

Boston Transit Commission. — *Dorchester Tunnel.* — Descriptions of Sections D, E, G and H were printed in the JOURNAL in October and December, 1915.

No change is reported in the status of Sect. D.

In Sect. E both shields are under the channel, the one for the easterly tunnel being several hundred feet in advance of that for the westerly tunnel.

Work was begun on Sect. G on Nov. 29, 1915. Tunneling under Dorchester Ave. near B St. for the 3 ft. x 5 ft. intercepting sewer is in progress; also excavation for the pump well at A St., the bottom of which will be 50 ft. below the surface of the street. The excavation for the incline for surface cars between A St. and West Fourth St. is also in progress.

The car tracks of the Boston Elevated Railway Company have been diverted from Dorchester Ave. between Andrew Sq. and West Fourth St.

On Sect. H the excavation has been nearly completed.

City of Boston. — PUBLIC WORKS DEPARTMENT, HIGHWAY DIVISION, PAVING SERVICE. — Work is in progress on the following streets:

East First St.,	from West First St. to H St.	Granite block.
Orleans St.,	from Grove St. to Porter St.	Concrete base.
Gladstone St.,	from Walley St. to Upland St.	Artificial stone sidewalk.
Lake St.,	from Commonwealth Ave., 1 720 ft. northerly.	Tar macadam.
Cornell St.,	from Orange St. to Colberg Ave.	Concrete base.
Montebello Rd.,	from Forest Hills St. to Walnut Ave.	Bitulithic.
Spring St.,	at hospital grounds.	Fence.
Poplar St.,	from Sycamore St. to Brown Ave.	Artificial stone sidewalks.
Morton St.,	from Washington St. to N. Y., N. H. & H. R. R.	Concrete base.
Hill Top St.,	from Granite Ave. to Hallet St.	Grading.
Harvard St.,	from Morton St. to Deering Rd.	Concrete base.
Dunlap St.,	from Washington St. to Whitfield St.	Concrete base.
Upland Ave.,	from Park St. to Melville Ave.	Concrete base.
Rosewood St.,	from Oakland St. to Randolph Rd.	Asphalt macadam.
Brunswick St.,	from Blue Hill Ave. to Normandy St.	Concrete base.
Randall St.,	from Harrison Ave. to Albany St.	Concrete base.
Worthington St.,	from Longwood Ave. to the Fenway.	Concrete base.

Boston Elevated Ry. Co. — *Bureau of Elevated & Subway Construction.* — The Company is completing at Harvard Sq. an escalator having a rise of about 22 ft. 6 in. from the second level of the surface platforms to the street level, to accommodate passengers arriving on both the upper and lower level surface-car platforms. The escalator is of the Reno or cleat type, and will be completed on or about the middle of January, 1916.

The Fore River Shipbuilding Co., Quincy, Mass., has the following work in progress:

Seventeen submarine boats.
Torpedo boat destroyers 63, 64 and *Tucker.*
Oil tankers *Texas* and *New York.*
Cargo vessel *Cubadist.*

Freight steamers *Edward Luckenbach* and *Julia Luckenbach.*

Molasses steamers *Sucrosa* and *Mielero.*

Two freight steamers for the Texas Company.

Two additional freight steamers for the Luckenbach Company.

One oil boat for the Government of Argentine.

Professor Lowell reports two new canals on Mars, but he does not tell our engineers how the Martian mudhogs handle slides and tidewash. — *Boston Herald.*

Charles R. Gow,
President, Boston Society of Civil Engineers,
1915–1916.

Vol. III JANUARY, 1916 No. 1

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications

THE WATER SUPPLY OF SALEM, MASS.

By William S. Johnson,* Member Boston Society of Civil Engineers.

(Presented October 20, 1915.)

The water works of Salem, like the city itself, have had a long and interesting history. In 1797 a memorial was presented to the General Court showing that the inhabitants of Salem "are poorly supplied with water, and at no time with water that will wash, and that at this time there are many wells that are dry, — that there are within a few miles of that town many ponds and springs from which the inhabitants of said town may be abundantly supplied with good water by means of an aqueduct. . . . Wherefore your petitioners pray that they may be incorporated for the purpose of bringing fresh water from said ponds and springs into the said town of Salem."

As a result of this petition the Salem and Danvers Aqueduct Company was incorporated in 1797, and works were constructed in 1798 to bring water from a reservoir 10 ft. deep and 24 ft. square into the city through a 3-in. log pipe. Water was first supplied in the spring of 1799, and the first dividend was declared in November of that year. This is one of the first water-works systems in this country built for the purpose of supplying water

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Note. Discussion of this paper is invited, to be received by Edward C. Sherman, Editor, 6 Beacon Street, Boston, before March 10, 1916, for publication in a subsequent number of the Journal.

* Sanitary and Hydraulic Engineer, Boston.

for fire and domestic purposes to the general public. Log pipes were used exclusively until 1834, when the first cast-iron pipe, 6 ins. in diameter, was installed in Essex Street.

For half a century this company continued to supply Salem with water. Frequently there was not enough water for the inhabitants, and it was necessary for the takers to install pumps in order to get water into their houses. Much of the time factories were not allowed to use the water, and there were constant complaints from the citizens. In 1851 a 12-in. main 16 000 ft. in length was constructed to bring water by gravity from Spring Pond in Peabody, one of the present sources of supply of that town. This pond is about 40 ft. above the central portion of Salem.

Eight years later, in 1859, complaints were again made of a shortage of water, and these complaints continued until in 1865 it became necessary to make a connection with Brown Pond in Peabody, another of the present sources of supply of that town. In 1863 it was reported by a citizens' committee that there was not a house where water flowed regularly to the second floor, and that out of 160 or 180 houses having bathtubs in the city, 123 were provided with pumps to raise the water for filling the tubs. Only two fire hydrants were available, and they would not throw streams into a second story or fill a hand engine, and the supply was so limited that a steam fire engine in Boston Street could interrupt the supply for the whole city.

In 1864 the city petitioned the legislature for authority to construct independent works, the supply to be taken from Wenham Lake in Beverly and Wenham. The hearings on this petition were very protracted, and the project was vigorously opposed by the Salem and Danvers Aqueduct Company, the inhabitants of Beverly, and by the mills at Ipswich. Notwithstanding the opposition, the legislature granted the city the right to construct its own works and to take a supply from Wenham Lake.

It was immediately after this action that the Aqueduct Company extended its pipes to Brown Pond, but the city went ahead nevertheless with plans for its own supply, and water commissioners were appointed to carry out the work. A chief engineer was appointed at a salary of $2 000 per year to design the works and have charge of construction, and his estimate of the cost of the entire plant was $497 332.

Work was begun in 1866, and in January, 1868, the work was reported to be not half done and the city had expended $445 736.86. At this time the services of the chief engineer were dispensed with and James P. Kirkwood, of New York, was appointed consulting engineer and Charles H. Swan, chief engineer. From this time the work appears to have progressed more smoothly, and water was finally turned on in December, 1868.

The works built at that time consisted of one Worthington duplex pumping engine with a capacity of 5 000 000 gals. per day, and a pumping station of sufficient size to hold a second unit similar to the first. Water was pumped through a 30-in. cast-iron force main 5 600 ft. long to the open distributing reservoir on Chipman Hill in Beverly. The reservoir is of earth, 400 ft. square, and has a capacity of 20 000 000 gals. The elevation of the reservoir is 115 ft. above the water in Wenham Lake, and about 100 ft. above the general elevation of the built-up section of Salem. A 20-in. cast-iron main was laid from the reservoir to the city, crossing the North River on piles with an inverted siphon beneath the channel. The distributing pipes, about 30½ miles in length, were entirely cement pipes. It is interesting to note that the cast-iron pipe cost $59.77 per ton.

The total cost of the work was $1 100 000, or more than $600 000 in excess of the engineer's estimate. The pumping station, estimated to cost $20 000, cost $103 243, and the reservoir, estimated at $50 000, cost $127 652. Other items were in much the same proportion, except the pump, which was installed for $35 117, somewhat less than the estimate.

The Salem and Danvers Aqueduct Company expired within a short time after the city works were installed. The city was restrained by the courts from interfering with the pipes of the company and was obliged, therefore, to go beneath them, but no redress was obtained by the company for the diversion of the business.

In the beginning Salem sold water to Beverly, but in 1886 that city constructed independent works. By the legislative act authorizing Beverly to do this work, it was provided that Salem should be entitled to two thirds of the water of Wenham Lake and Beverly to one third, and that Beverly should pay to Salem one third of the cost of maintaining the supply.

In 1873 a second pumping unit similar to the first was installed, and in 1890 a new 30-in. cast-iron main was laid from the force main through Danversport to Salem, a distance of 5¾ miles. Five years after the works were installed, in 1873, the water commissioners called the attention of the citizens to a shortage of water and advised that application be made to the legislature for permission to take the water of Ipswich River as an additional supply. Nothing was done, however, in the way of additional supply until 1894, when works were constructed for taking water from Longham Brook, a small stream east of Wenham Lake, the water being diverted into the lake by gravity through a 36-in. pipe.

Since this diversion of water from Longham Brook little has been done to the plant until the present year. The lake has been drawn to so low a level on several occasions as to require an auxiliary pumping plant to raise the water so that the regular pumps could draw it, and several times the spring flows have failed to fill the lake. In the meantime the plant has been paying all expenses and turning into the city treasury from $60 000 to $75 000 per year. In 1910, alarmed by the low water in the lake, the authorities of Salem and Beverly engaged the writer to advise them, and the recommendation was made that works be constructed for diverting as much water as was necessary from Ipswich River and for discharging it into the upper end of Wenham Lake. The cities petitioned the Legislature of 1911 for authority to take the water, but much opposition was encountered. The town of Peabody wanted water from the river, the towns on the stream did not wish to have the water diverted, and the mills claimed that by such diversion they would be seriously injured. The Metropolitan water supply was urged by the opposition as the only reasonable supply for all the towns, and in order to get further light the legislature referred the whole matter to the State Board of Health for investigation and report. The board made as thorough an investigation as was possible in the limited time, and reported early in 1912. It found that in the winter and spring a large quantity of water flows off through the Ipswich River which might reasonably be used for supplying Salem, Beverly and Peabody, but found no place which could be used for the storage of this water in large quantities without creating objectionable conditions. The existing reservoirs in these towns might, however, be utilized for this purpose and enough water secured in this way from the Ipswich River to last for several years, — probably not more than ten, — after which it would be necessary to secure a further large additional supply, and the board stated that such a supply can only be obtained from the Metropolitan Water District. It further suggested that the cost of taking water at once from the Metropolitan District might be less in the long run than the cost of using the Ipswich River for ten years and then going to the Metropolitan District.

A further suggestion made by the board which had a very important bearing on the future troubles was that Beverly might purchase Salem's rights in Wenham Lake, thereby securing for that city a source of supply adequate for many years, and that Salem might then enter the Metropolitan District. This proposition was enthusiastically received by the authorities of Beverly and met with immediate and strenuous opposition in Salem. Furthermore, the estimates made by all of the engineers for Salem had indicated that the cost of the Metropolitan supply would be much greater than the cost of a supply from the Ipswich River, especially as the development of the river supply need not be made at once, but could reasonably be made from time to time.

The city of Salem, therefore, insisted on obtaining the right to take water from the Ipswich River, Beverly wished to obtain Wenham Lake, and Peabody objected to being forced into the Metropolitan District. After many hearings the legislature finally passed a bill providing for a special commission of three to investigate and report at the next session. A commission was appointed in June, 1912, consisting of Thomas W. Proctor, John F. McDonald and our honored president, Mr. Charles R. Gow. Mr. Guy Emerson was made engineer for the commission, and Mr. Allen Hazen, consulting engineer.

Now began a contest in which were engaged nearly all of the water-works engineers in this section of the country. Beverly was represented by the late George A. Kimball and R. S. Weston, Peabody by A. W. Cuddeback, Danvers by L. D. Thorpe, the towns in the valley by Metcalf & Eddy, and Salem by the writer, with F. A. Barbour and George W. Fuller as consulting engineers on certain features of the work. Practically every city and town in the valley was represented by counsel and by town officials. The commission held fifteen hearings, and their engineers made quite elaborate independent investigations.

Before the commission was appointed it became evident to the city of Salem that with so many conflicting interests the matter was becoming so complicated that it would be highly desirable to have a thoroughly worked-out plan for the supply of Salem and Beverly for an indefinite time in the future, including the storage reservoirs which must come some time if the Ipswich River supply was to be depended upon, and that everything must be worked out in sufficient detail to meet any possible questions which might arise. Accordingly such plans were prepared, and, as the future doings centered around these plans, and as the result was their final adoption, it may be well to describe them briefly here.

Salem, as already stated, is entitled to two thirds and Beverly to one third of the water in Wenham Lake, supplemented by Longham Brook. Wenham Lake has a watershed of 3.5 sq. miles, an area when full of 250 acres, and a storage capacity to a level 20 ft. below high water of 1 200 000 000 gals. Besides the visible storage, there is available an unknown but certainly large storage in the surrounding soil, which consists chiefly of porous sand and gravel. Longham Brook has a watershed of 3.3 sq. miles, and it is possible to divert all of the water into the lake except at times of very high flow, when some goes by the dam. The estimated yield of Wenham Lake alone, drawing water to 20 ft. below high water, is 3 000 000 gals. per day, and with Longham Brook is 5 000 000 gals. per day.

The consumption of water in Salem in 1912 was 3 767 700 gals. per day, or 82 gals. per capita, and in Beverly 1 830 000 gals. per day, or 91 gals. per capita. The total consumption in the two places, 5 597 000 gals. per day, was beyond the safe yield of the sources of supply, and the rate of increase in the consumption was rapid in both places.

Meters are not in general use in either of the cities, but a careful study of the consumption and of the requirements in the two cities indicated that while the increase might be checked, it would not be possible to reduce the consumption materially by the general use of meters. Manchester, the next town to Beverly, and having somewhat similar conditions, uses 113 gals. per capita per day, or 21 gals. more than Beverly, and in Manchester every service is metered. In Salem, although only 3 per cent. of the services are metered, about 25 per cent. of the total water used passes through these meters, so that the reduction possible by additional meters must be comparatively small. The plans and estimates were all based on a total consumption in 1938 of 11 100 000 gals. per day by the two cities.

In its natural condition the water of Wenham Lake is of excellent quality, being almost colorless and containing a very small quantity of organic matter. The water of Longham Brook is highly colored and contains an excessive quantity of organic matter derived from the swamps through which it passes. The effect of the discharge of this swamp water into Wenham Lake has been very noticeable and the lake water now has a color and is subject to disagreeable tastes and odors.

The only possible sources of supply for Salem and Beverly which would furnish sufficient water to make them worthy of consideration are the Ipswich River and the Metropolitan waterworks. Concerning the quantity and quality of the Metropolitan supply there can be no question. It is certain that a sufficient quantity of good water will always be provided. The only question in regard to this source is as to the expense, and this is a matter of great uncertainty. In determining the probable expense of the Metropolitan supply, it is necessary not only to know the cost of entering the district and the assessments based on present conditions, but it is also necessary to make some estimate of future conditions. The present Metropolitan supply is capable of supplying the district which it now serves for only a limited time, when very expensive additions must be made. Furthermore, the district is expanding all the time, and thus increasing demands for water are being made. Filtration of the supply, or a part of it, will undoubtedly come in the not far distant future. On the other hand, the district will begin to take up its bonds by about 1938, which will reduce the expenses very materially, and the introduction of meters is lessening the consumption and thus increasing the length of time for which the present sources will be sufficient.

Another uncertainty is the possible action of other communities. If Salem alone in this vicinity should enter the district, it would be necessary to pay the entire expense of a pipe line from Spot Pond and other necessary works. If other communities should enter at the same time, the cost to Salem would be much reduced.

Ipswich River, the only other available source, flows within about two miles of Wenham Lake, and is at about the same elevation. Its water could be discharged into the upper end of Wenham Lake by pumping over a low ridge. At a point near Wenham Lake the river drains a watershed of about 95 sq. miles. It is bordered by extensive swamps, and for many miles has but a slight fall, and the water is highly colored, especially at certain seasons of the year.

The seasonal flow of the river is very interesting. In general, the lowest dry weather flows are expected on steep, impervious watersheds, but on the Ipswich, with a very flat watershed, we have unusually low summer flows, due, of course, to the evaporation from the extensive water surfaces presented by the swamps.

In some years it would be practically impossible for several consecutive months to get any water whatever from the river, and it would be necessary, in order to utilize the stream to its fullest extent, to have sufficient storage capacity to store the spring flows for use in the dry months. Wenham Lake would provide a large storage capacity by drawing the water to a low level, but when the consumption becomes greater it will be necessary to provide additional storage. An excellent site for a reservoir was found in Putnamville, where more than 1 500 000-000 gals. could be stored at an elevation somewhat above Wenham Lake, but the water from the Ipswich River would have to be pumped to it. Another site for a reservoir was found in the immediate vicinity, and with these two reservoirs the Ipswich River would be sufficient to supply Salem and Beverly for an indefinite time in the future.

In order to improve the quality of the Ipswich water before discharging it into the lake, it was proposed to pass it through sand filters built in the natural soil on the shore of the lake, these filters being in construction much like intermittent filters for sewage.

Water would be pumped from the Ipswich River in winter and spring to fill Wenham Lake and the storage reservoir. The water pumped into the reservoir would remain there for at least six months, getting the benefit of storage; then in the fall it would be discharged by gravity to the filters on the shore of the lake, thence passing into the lake at the upper end, where it would mingle with the water already there, and pass slowly to the intake at the other end. As a part of the plan, slow sand filters were to be constructed at the pumping stations for the purification of the mixed waters.

This is the plan which Salem presented. Other schemes were submitted by the other parties interested, and the Metropolitan supply for Salem was strongly urged by all except Salem. Mr. Hazen, the commission's consulting engineer, proposed the flooding of the extensive swamps bordering the Ipswich River, thus forming an enormous storage reservoir on that stream sufficient for all of the communities in the vicinity.

The commission finally reported to the legislature in the early part of 1913, recommending substantially the adoption of the plan prepared by Salem, but restricting the quantity of water which might be drawn from the Ipswich River.

The legislature, after still further hearings, passed a bill incorporating the recommendations of the commission and providing that the work be done by a board comprising a chairman, to be appointed by the governor, the director of public works of Salem, and the chairman of the Water Board of Beverly. The time in which water may be drawn from the river is limited by the act to the months from December to May inclusive, no water to be drawn except when the daily flow is 20 000 000 gals. or more, and then only the quantity in excess of that amount and not more than 2 500 000 000 gals. to be drawn in any one season.

Mr. Allen Hazen was appointed engineer of this board, and the execution of the plans has been begun. The works for diverting water from the Ipswich River directly into Wenham Lake are now nearly completed, and it is probable that the reservoir and filters will not be constructed at present.

The future supply of the city having been settled, the people of Salem were beginning to forget the water troubles and turn their attention to grade-crossing elimination and other much-needed improvements, when in June, 1914, came the great fire which wiped out the buildings in an area of 253 acres with a property loss of $15 000 000.

The story of the conflagration is so well known that it is not necessary to repeat it here except so far as it has influenced the further development of the water works. The water-works system did everything that could be expected of it. At the beginning of the fire the 20 000 000-gal. reservoir was about full, and during the fire lost only 500 000 gals. The pumps both operated continuously and there were no breaks in the mains until after the fire was checked, when a 12-in. cement main burst. Although everything worked as it should, the Salem plant failed utterly to give water enough to fight the fire without the assistance of the surrounding towns.

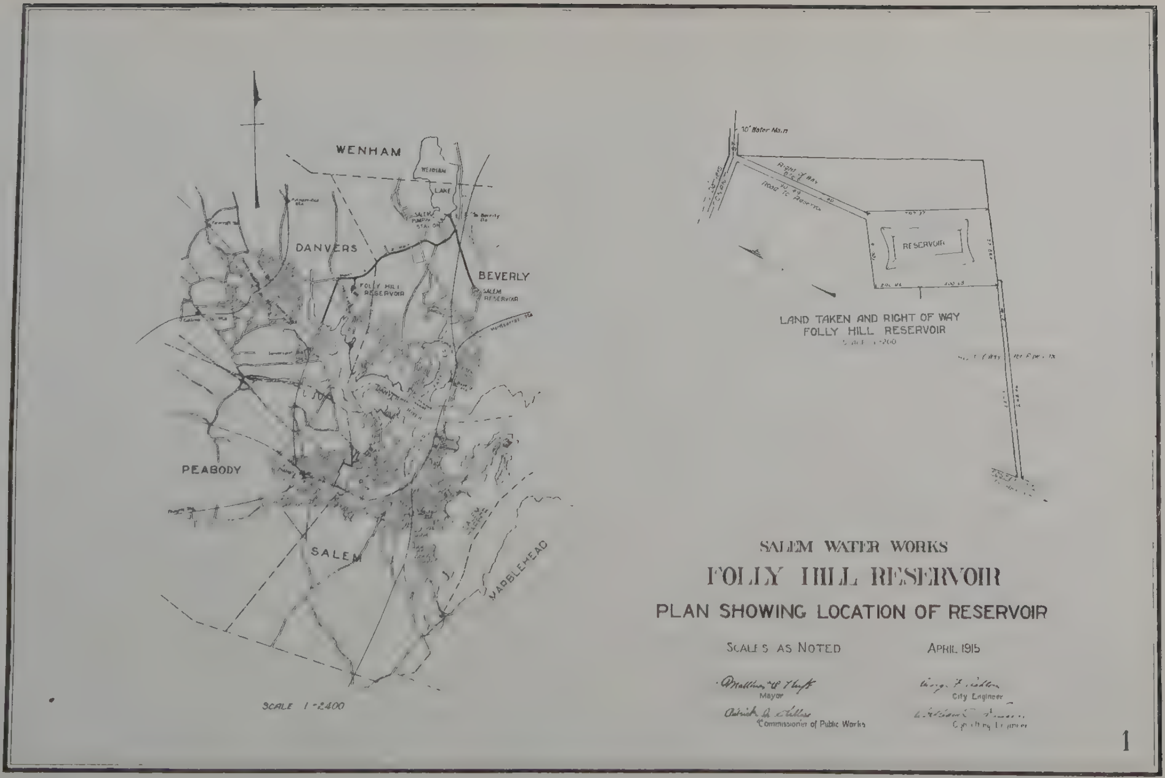
With wise forethought the city authorities had made connections with the pipes of all of the surrounding towns, and during the height of the fire water was being drawn from Peabody, Danvers and Beverly. The connection with Marblehead was opened for but a short time, as the plant is dependent to a large extent on the electric current from the Salem Electric Light Station, which was put out of commission by the fire. All of the surrounding towns have a higher pressure than Salem. The maximum quantity of water used and lost through bleeding services during the fire was at the rate of about 18 000 gals. per min.

The Salem system is a low-pressure system, dependence being placed on steamers for fire protection. The normal pressures in the thickly built-up sections are from 40 to 50 lbs., and on the outskirts in the higher sections the normal pressure is only about 10 lbs. The city is fed from the reservoir by a line of 30-in. pipe 5¾ miles long and a 20-in. line 4 miles long, the latter having been in use for nearly fifty years. When the two lines of pipe are delivering 10 000 gals. per min. the pressure in the center of the city is reduced to 28 lbs. The capacity of these lines of pipe had been carefully figured by the city engineer previous to the fire, and it was largely due to his foresight that the connections with the other supplies had been made.

After the fire every one realized the importance of a large quantity of water under good pressure, and immediately the city government took steps to obtain it. This meant something more than a new reservoir and pipe line, for the city still had some 18 miles of the old cement pipes which could not stand an increased pressure, and the old pumps were entirely incapable of pumping against an increased head.

The work of replacing the cement-lined pipe with cast-iron was begun at once, and at the same time the distributing system was improved by providing feeders of large size for the different sections of the city. The work of substituting cast-iron for the cement pipes is now about completed. The use of the old Lowry chuck hydrants, which Salem has clung to for many years, has been discontinued and post hydrants have been used on all new lines.

The increased pressure and volume of water have been obtained by the construction of a new reservoir on Folly Hill in Danvers. The old reservoir was at elev. 145 and the main feeder into the city was a 30-in. pipe 5¾ miles in length. The reservoir on Folly Hill will be at elev. 209 and will feed the city through a new 36-in. main 3¼ miles long and a part of the old 30-in. main 4 miles long. The capacity of the new reservoir will be 10 000 000 gals., or one half the capacity of the old reservoir.


WENHAM
WENHAM LAKE
SALEM PUMPING STATION
DANVERS
BEVERLY
SALEM RESERVOIR
FOLLY HILL RESERVOIR
PEABODY
SALEM
MARBLEHEAD
SCALE 1"=2400
10" Water Main
Right of Way
Road to Reservoir
RESERVOIR
LAND TAKEN AND RIGHT OF WAY
FOLLY HILL RESERVOIR
SALEM WATER WORKS
FOLLY HILL RESERVOIR
PLAN SHOWING LOCATION OF RESERVOIR
SCALES AS NOTED
APRIL 1915
Mayor
City Engineer
Commissioner of Public Works
Consulting Engineer
1

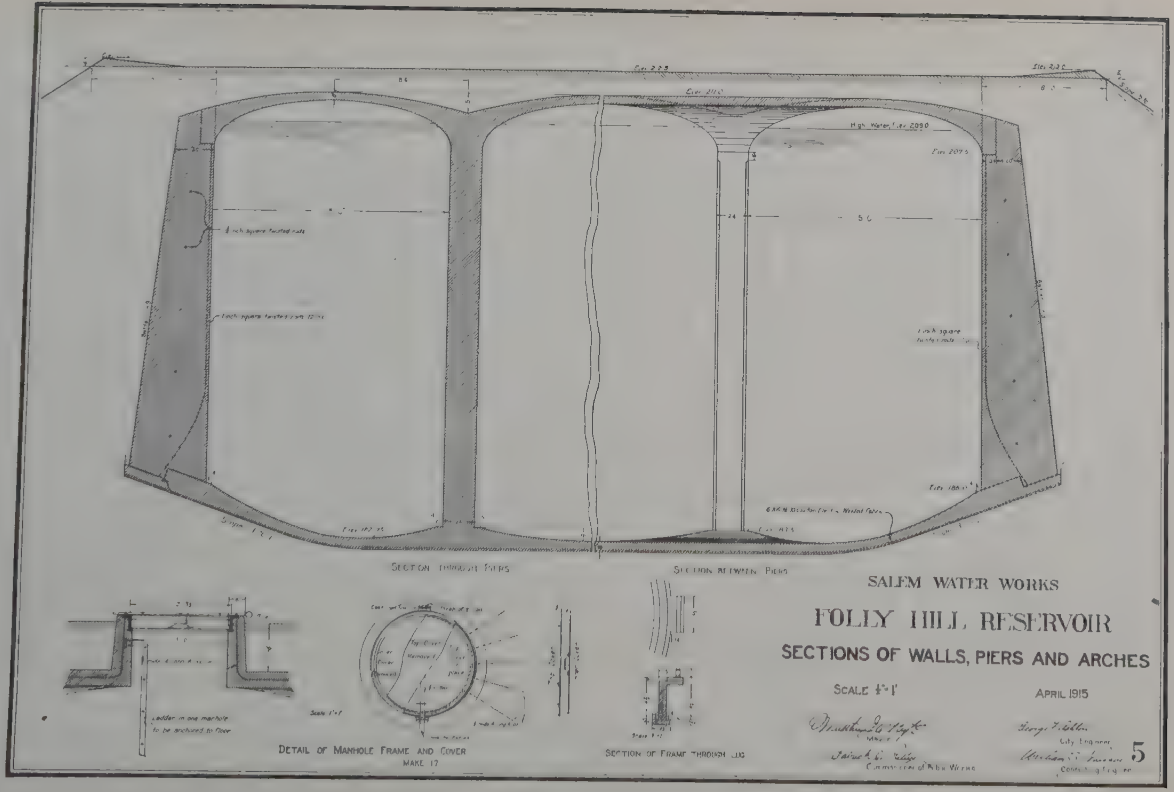
These two pipe lines will be capable of delivering the quantity of water used during the height of the Salem fire with a loss of pressure of about 13 lbs. During ordinary consumption the pressures in the city will be increased from about 50 lbs., as at present, to about 78 lbs.

Folly Hill makes an excellent site for a distributing reservoir, not alone for Salem but also for the surrounding towns, and when the reservoir is completed Salem will be in a position to help the towns which gave such valuable assistance during the fire. When suitable connections are made, this reservoir will give better fire protection for Danvers and Beverly than can be obtained from their own works, and will be of the greatest assistance to Peabody. It could also be used to supply Marblehead by the construction of a comparatively short pipe line.

The highest point on the hill is elev. 205, but the topography is not what might be desired for a reservoir, being a long narrow ridge. It was desirable to get as great an elevation as possible, and various plans were worked out, including circular tanks, but it was finally decided to construct a 10 000 000-gal. rectangular reservoir with a groined arch roof, high water to be at elev. 209 and extreme low water at elev. 182.75. The dimensions of the reservoir, which were determined by the shape of the hill, are 406 ft. by 134 ft.

The covered reservoir was determined on because the water will at some time be filtered, and while it is somewhat uncertain what the effect will be of storing the filtered water in an open reservoir, it is possible, to say the least, that disagreeable growths of organisms may occur unless the water is protected from the light.

The design of the reservoir is not novel, although in some respects it differs from many of those which have been built. The floor is constructed in two layers, the first layer, 5 ins. in thickness, being flat and reinforced with 6-in. by 6-in. mesh, No. 10 Clinton welded wire. The upper layer is 3 ins. thick midway between the piers and 12 ins. thick at the piers. The floor is brought up at the sides, and ends on a slope of one vertical to three horizontal to about three feet above the elevation


Elev. 223
Elev. 212.0
Elev. 211.0
Slope 2:1
8.0
84
5
6
30
High Water, Elev. 209.0
Elev. 207.5
24
5.0
¼ inch square twisted rods
1 inch square twisted rods 12" c.c.
1 inch square twisted rods
Elev. 186.0
6 X 6 N Boston Fire Co. Metal Fabric
Elev. 187.75
Slope 1 : 2
SECTION THROUGH PIERS
SECTION BETWEEN PIERS
Ladder in one manhole to be anchored to floor
Top Cover
Remove
Scale 1" = 1'
DETAIL OF MANHOLE FRAME AND COVER
MAKE 17
Scale 1" = 1'
SECTION OF FRAME THROUGH LUG
SALEM WATER WORKS
FOLLY HILL RESERVOIR
SECTIONS OF WALLS, PIERS AND ARCHES
SCALE ¼" = 1'
APRIL 1915
Mayor
City Engineer
Commissioner of Public Works
Consulting Engineer
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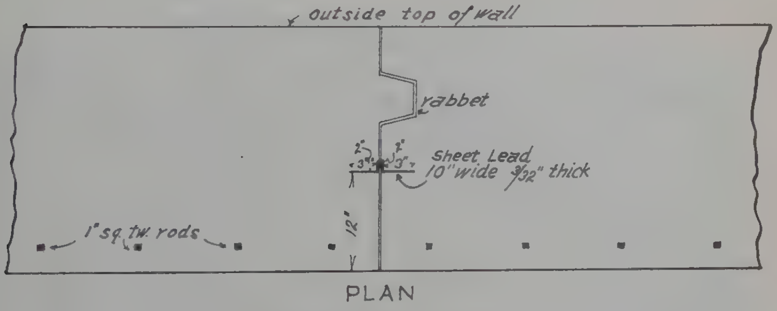
of the main floor, and the side walls rest on this. The side walls are 21.5 ft. high to the springing line of the arch. They are 2.5 ft. thick at the top and have a batter on the outside of one in nine, the inside face being vertical. The approximate thickness of the wall at the bottom is 5 ft.

The floor of the reservoir has a slope of 6 ins. from the ends toward the inlet sump at the center.

The walls are reinforced to withstand the pressure of the earth embankment when the reservoir is empty. This reinforcement consists of vertical 1-in. square twisted rods spaced 12 ins. on centers. At the joint between the floor and the wall, and at all other horizontal joints below the springing line of the arches, there are placed two strips of No. 20 steel, 6 ins. wide, to act as dams and lessen the leakage of water through the joints. The vertical joints are made watertight by a bent strip of sheet lead 10 ins. wide and 3/32 in. thick. The 161 piers are of plain concrete 2 ft. square with a 2-in. chamfer on the corners and are 24 ft. high. They are spaced 17 ft. on centers and rest on bases 2 ft. 8 ins. square formed by the floor. On these piers rest the elliptical roof arches, which are 6 ins. thick at the crown and have a clear span of 15 ft. and a rise of 3 ft. The roof is depressed 15 ins. over the piers. In it are placed seventeen manholes with double iron covers.



VERTICAL JOINT.

The earth which was excavated will be placed on the top of and around the reservoir. The depth of earth covering on the top above the soffit of the arches will be 18 ins. The embankment will be carried out to a point 7 ft. 3 ins. from the inside of the reservoir walls and will then have a slope of one and one-half horizontal to one vertical.

On the easterly side of the reservoir is a chamber built on the wall to provide for the overflow. In the bottom of this chamber is a 16-in. pipe leading to a tile drain which discharges at the bottom of the hill.

The gatehouse is to be of hollow tile construction with a surface of plaster and a red tile roof. It will contain, besides the gate stands, the registering apparatus for the 36-in. meter which is to be installed just beyond the inlet to the reservoir.

The earth excavation for the reservoir was done by day work in order to provide employment for some of the many men thrown out of work by the fire. About 30 000 cu. yds. of very hard material were removed at a cost of $22 000, or about 73 cents per cu. yd. The earth removed was placed in the embankments as far as possible and the remaining material was placed in spoil-banks. This is a wasteful method of doing the work, as it means handling much of the material twice, but it was considered advisable not to have the city workmen and the contractors' workmen on the job at the same time, one reason being that the city laborers were paid at a rate of about 35 cents per hour, while the contractor's men receive about 20 cents.

The contractors for the work are A. G. Tomasello & Son, and they receive the following prices:

Item.	Estimated Quantity.	Unit Price.
Earth excavation.	1 000 cubic yards.	$1.00
Earth fill.	25 000 cubic yards.	.35
Concrete in piers and arches.	2 200 cubic yards.	8.45
Concrete in floor.	1 850 cubic yards.	7.00
All other concrete.	3 300 cubic yards.	6.30
Reinforcing steel.	53 tons.	75.00
Gatehouse.	Lump sum.	1 400.00
Fertilizing and seeding.	3 acres.	100.00
Appurtenances.	Lump sum.	700.00

The total price, based on the estimated quantities, is $68 455, not including the work done by the city, which amounted to about $22 000.

The 36-in. pipe line has not yet been constructed. It will enter the city by a new route, crossing the Danvers and North rivers.

What the effect of the increased pressure on plumbing will be is somewhat uncertain. Salem has been provided with a water supply since 1797, and while there may be no plumbing which was installed at that time, some of it must have been put in shortly after. Some trouble is anticipated. Furthermore, while all of the cement-lined pipe, so far as known, will have been replaced before the higher pressure is turned on, it is suspected that there may be short lengths still remaining which are unknown, as the records were not always so well and systematically kept as they are now.

Much consideration was given to the type of pumping plant to be installed. Two 10 000 000-gal. units were desired, and it was desirable to use the old pumping station if possible.

The pumps must be able to draw at least 25 ft. from the lake, which means that they must set very low in the station. When the old pumps were installed much difficulty was experienced with the foundations and with the construction of the pump well in the station, on account of water and quicksand.

The best bid received was one of $30 280 from the Power Equipment Company for DeLaval centrifugal pumps and steam turbines, the guaranteed duty being 140 000 000 ft.-lbs. per 1 000 lbs. of steam. The best proposition for reciprocating engines was from the International Steam Pump Company for Snow horizontal cross-compound steam pumps, the guaranteed duty being 165 000 000 ft.-lbs. and the cost $41 100 above the foundations.

Comparatively little is known regarding the depreciation or repairs of such a plant as that offered by the Power Equipment Company, but after allowing liberally for these items and considering the cost of the foundations, which were to be furnished by the city, it was decided to accept the bid for the turbo-centrifugal plant.

Each unit will consist of two 16-in. centrifugal pumps in series, operated by a 460 horse-power steam turbine. The condenser will be of the water-works type placed in the suction, and it is expected that a vacuum of 29 ins. will be maintained under ordinary conditions. Steam is to be furnished from the present boiler plant, but Foster superheaters are to be installed.

There are already three intakes in the lake, but none of them is suitable for the new plant, so a new 36-in. intake is to be installed with an intake chamber and gatehouse. Arrangements will be provided so that water may be drawn at either of two levels, the lower opening being 25 ft. below high water.

The contract for this work has been awarded to the Bay State Dredging Company of Boston for $13 800. The total expense of all of the improvements to the system, exclusive of the work on the Ipswich River supply, will be $500 000.

DISCUSSION.

Mr. Charles R. Gow.* Referring to the work of the special commission appointed by the governor in 1912 to investigate the whole question of a water supply for Salem and some other municipalities, as mentioned by Mr. Johnson, and on which I had, as he has stated, the honor to serve, I wish by way of discussion to add a few words to what has been said.

I am particularly impressed by one fact as I view the matter in retrospect, and that is the continued adequacy of the old supply after a lapse of more than three years, in spite of the conviction of the commission and all other parties concerned at the time that the cities and towns considered were in imminent danger of a water famine and that immediate relief was imperative. As engineers, we, of course, readily understand the reason for this seeming anomaly, viz., the difference between a safe and a normal yield of a given supply. It is quite difficult for the average lay mind to grasp this distinction, and it is unfortunate for us that such is the case. The fact that the past few years have brought a return of normal yields in the ponds and streams after a series of extremely dry seasons will in all probability not be appreciated by the general public to such an extent as to eliminate entirely the impression that the engineers erred in judgment. Happily, now, it appears that the danger of shortage is at an end and the new supply will soon be made available.

One of the several interesting questions presented for the consideration of the commission was that submitted by the city of Beverly, whose representatives maintained that, because Wenham Lake was situated partially within the geographical limits of that city while none of it bordered upon any part of Salem, the latter municipality should be compelled by the Commonwealth, now that the supply was inadequate for both cities, to surrender all of its rights and interest in this supply to the city of Beverly. Here, then, was a city which had enjoyed water privileges in one of the Commonwealth's great ponds for nearly fifty years under a grant of the legislature; had invested large sums of money in plant, equipment and pipe lines in addition to that for improvement of the supply itself; had first, by direction of the Commonwealth, supplied water for the purposes of Beverly and later divided the supply with that city under a joint arrangement, and now it was urged that it be compelled to abandon all of this investment and seek an entirely new supply elsewhere.

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* The Charles R. Gow Co., General Contractors, Boston.

There seemed to be no precedent available as a guide to the commission, and while it was apparent that the Commonwealth which granted the original rights to Salem presumably could revoke them at any time, it was extremely doubtful in our minds that such action would be taken without a provision for adequate compensation. In the event of the payment by the city of Beverly of any sum that would reasonably reimburse the city of Salem for its sacrifice, there would result a greater cost to the first-named city than would seem to come from continued joint action between the two municipalities. The suggestion was, therefore, rejected by the commission.

Careful consideration was also given to a proposed plan for including Salem and possibly some other towns and cities in the neighborhood within the group to be supplied from the Metropolitan water system. There appeared to the commission to be at least two serious objections to this proposal. First, from the standpoint of the municipalities themselves, it was found to entail the greatest expense of all the suggested measures of relief, and the proposal, therefore, met with bitter opposition from the inhabitants thereof. No municipality located within the geographical limits of the Metropolitan District had ever been compelled against its wishes to join the system, and there seemed all the more reason why places as remote from the district as Salem should not be forced to assume the financial and other burdens entailed by membership in the Metropolitan water system. Second, from the standpoint of the Commonwealth, and especially of the Metropolitan District, it seemed to the commission to be questionable whether it would be wise to extend the limits of the system to points as remote as Salem and the other municipalities. It would bring about a much earlier exhaustion of the existing Metropolitan supply, with the consequent necessity of taking new sources from other parts of the state wherever they might be available. Furthermore, there was a sufficient and satisfactory supply close at hand for these cities and towns, and it was, therefore, determined to recommend the development of the Ipswich River waters for the purpose.

For the relief of the cities of Salem and Beverly it was recommended that the river water be pumped to a new storage reservoir, utilizing the flood flows in the river during the winter months, in order that the Wenham Lake supply might be amplified during the summer months of shortage. The commission was impressed with the storage feature in connection with its conclusions because of the high color of the river water and the consequent difficulty of removing it by means of slow sand filtration. It was recognized as practically conclusive that mechanical methods of filtering would successfully meet the color difficulty, and there was much cumulative evidence presented by eminent authorities on the subject of filtration tending to prove to the commission that the mechanical method was, all things considered, the more desirable method for adoption, in this case. The commission was aware, however, of the opposition on the part of the State Board of Health to the use of mechanical methods of filtration wherever such use could be avoided, and for this reason it was deemed preferable to adhere to practices which would not conflict with a settled policy of a responsible state department such as our Board of Health.

The recommendations of the commission as reported to the legislature were finally adopted and enacted into law with the exception of the provision for the storage reservoir, which was deemed to be unnecessary for the present. Since that time additional legislation has been secured altering some features, especially that relating to the point of taking the water from the river and of conducting it to Wenham Lake.

Referring to the construction work on the new high-service reservoir which Mr. Johnson has described and illustrated, and which many of us had the pleasure of inspecting to-day, I wish to congratulate him and his contractors upon the excellent quality of the workmanship attained. It has fallen to my lot to construct or supervise the construction of much work of a similar character, and I will say without reservation that I consider this work the equal in appearance and general excellence of workmanship of any I have seen. This of course reflects great credit on the engineers and officials who have supervised the work, but at least equal praise is due the contractors, without whose ability and superintendence such results could not have been obtained.

I wish to comment especially upon the small amount of plant used by this contractor in carrying on the work, and the apparent efficiency and economy of the methods which he has applied. I have long realized the tendency to over-plant jobs of this kind, and was, therefore, interested to note the effective results being obtained in this instance by comparatively simple methods. The large amount of form work required for this class of work in comparison with the amount of concrete used makes possible the placing of only moderate quantities of the latter material in a given day. The overhead cost of elaborate handling devices may, therefore, more than offset the apparent saving in labor.

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PAPERS AND DISCUSSIONS

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MEMORANDA ON CERTAIN EARLY TYPES OF TURBINES OR OTHER WATER WHEELS.

BY CHARLES W. SHERMAN,* MEMBER BOSTON SOCIETY OF CIVIL ENGINEERS.

Rose Wheel. (Fig. 1.) This is a downward flow wheel consisting of a cast-iron runner, as shown in the photograph, with vanes flat or nearly so, supplied with water through a cast-iron nozzle connected to the end of a rectangular wooden flume or conduit. The nozzle is divided into two parts by a vane or guide and covers somewhat less than half the upper surface of the wheel. The wheel is, therefore, something between an impulse wheel and a vertical flow turbine.

Blake Wheel. (Fig. 2.) This is an inward flow turbine of a primitive type.

Chase Wheel. (Fig. 3.) The photograph shows very imperfectly a view of a 30-in. turbine made by the Chase Turbine Mfg. Co., of Orange, Mass. This wheel was supplied through a rectangular wooden conduit connecting with a cast-iron section and discharging into the side of the wheel case. In the cast-iron section is a butterfly valve by which regulation was accomplished. The spaces between the buckets were small, and another wheel of this type, which had been removed, showed the spaces to be plugged up to considerable extent with stones.

Hunt Turbine. (Fig. 5.) The wheel illustrated was manufactured by Hunt, Waite & Flint, Orange, Mass., and the name-plate indicates that it was patented in 1869. This is an inward and downward flow wheel, and, as is shown by the photograph, the spaces between the buckets are very small. The wheel has been whitewashed since its removal. Careful inspection of the picture will disclose the presence of a large number of sticks and stones which, in considerable measure, clog up the spaces between the buckets.

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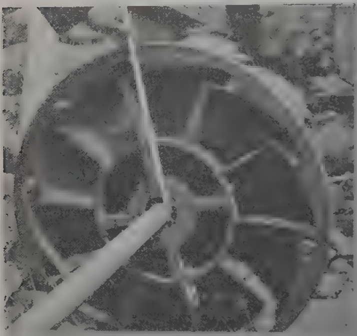
* Of Metcalf & Eddy, Consulting Engineers, Boston.



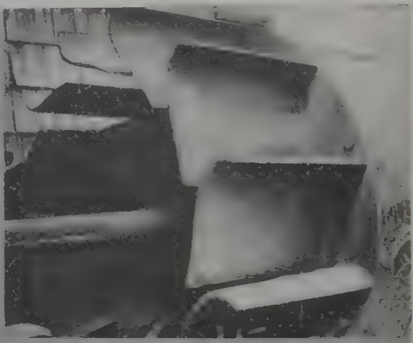


Fig. 1. Rose Wheel.

Fig. 2. Blake Wheel.

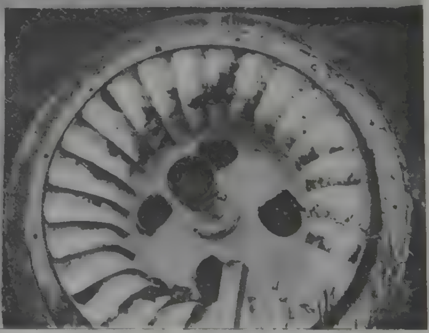


Fig. 4. Stevens Wheel and Case.

Fig. 5. Hunt Wheel (Old Pattern).

Stevens Wheel. (Fig. 4.) The photograph shows somewhat imperfectly the features of the gates and of the runner of a turbine made by G. C. & J. F. Stevens, Ayer, Mass., patented in 1872, and at one time rather popular in northern Massachusetts and southern New Hampshire. This is an inward flow wheel with vanes rather sharply curved.

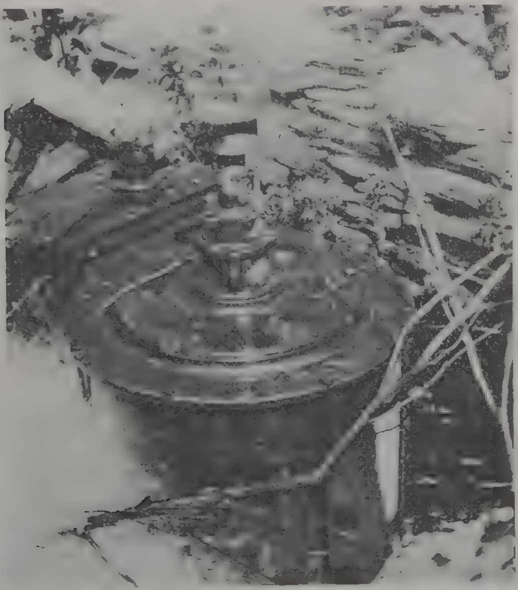


FIG. 3. CHASE WHEEL.

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JOINT MORTAR EXPOSED TO TIDAL CURRENTS.

By John L. Howard,* Member Boston Society of Civil Engineers.

In building sea walls of coursed granite masonry laid in mortar and exposed to the action of tidal currents, where the bottom course is not more than one foot above mean low water, much difficulty is often encountered in holding the mortar in the joints long enough to give it time to set, as the action of the tides rising and falling on the fresh mortar will pull it out of place. It does not matter how rich a mixture is used, whether 1 : 1 or neat cement, it is impossible to keep the mortar in place till it hardens.

On one piece of construction under the writer's supervision this difficulty was successfully overcome by mixing plaster of Paris with the mortar in the proportion of one part of plaster of Paris to three parts of 1 : 1 mortar. This mixture hardened within five minutes, and no further trouble was experienced from the mortar in the joints failing to set in place, and the pointing of the joints in which this mixture had been used was entirely satisfactory.

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* Assistant Engineer, Directors of the Port of Boston.

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DISCUSSION OF SOME SPECIAL METHODS OF REINFORCED CONCRETE DESIGN.

By J. R. Worcester, H. B. Andrews and M. J. Lorente.

Mr. J. R. Worcester* (*by letter*). — It is unfortunate that this paper, which embodies so much information in tabular and diagrammatic form, should be impaired by the condensation of the descriptive matter to such an extent as to be almost unintelligible. The confusion is partly due to inexcusable omissions, such as the explanation of the notation used in the first three equations, and partly to the absence of a clear explanation of the successive steps in the reasoning. For instance, in describing the method of obtaining the moment of resistance of the T-beam, it should be noted that the moments of the subtracted areas are those about the neutral axis of the section as a whole and not about their individual axes. It should further be explained that the whole paper is limited in application to beams with balanced reinforcement, that is, with just enough steel to produce simultaneously the desired stresses in both concrete and steel. As all designers know, this condition is comparatively rare. Of course, by having enough tables to cover a sufficiently wide variation between compressive and tensile stresses it may be possible to find a beam somewhere near the desired section, but this appears to be a backhanded and cumbersome method to adopt.

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*J. R. Worcester & Co., Consulting Engineers, Boston.

In the design of rectangular beams reinforced in compression, the method of Messrs. Clifford and Mangold is much more useful and concise. Their diagrams and tables are easy to understand and to use, and should prove very valuable to designers.

Mr. H. B. Andrews* (*by letter*). — The need of standard methods for designing reinforced concrete members has long been perceived, and it was with the view of establishing recognized standards that committees were appointed in 1903 and 1904 by several engineering societies. The 1913 report was a culmination of their investigation, and this report recommended formulæ covering the ordinary features of design. This report also included the ground covered by Mr. Lorente in his paper. While Mr. Lorente's paper is very interesting and apparently worked out on a reasonable basis, the final results attained are not so very different from recommendations of the Joint Committee.

It would seem that the report made by this committee, composed of the best engineers of this country, should be sustained unless there was some well-grounded reason for taking exceptions to it.

There is this, however, to say about the Joint Committee's report. It is not in practical shape for use by the designer, and will not be until standard sections are worked out and tabulated so that the designer can obtain his concrete sections as easily as he can steel sections from a structural steel handbook.

I have endeavored to work out a practical and ready method of using the recommendations of the Joint Committee in some diagrams and tables which I have not published, but have some blue-prints of, which I would be glad to show to members of the Society.

There is a limit to the sectional area of steel that can be used in a 1 : 2 : 4 concrete; p must not be greater than .89 per cent. for rectangular beams, and not greater than 2.13 per cent. of the rectangular section of T-beams. The limiting factor in the first case is the allowable compressive stress in the concrete, which is 715 lbs. per sq. in., and in the second case, the same allowable compression in the bottom of continuous beams at supports plus the compression in one half of the reinforcing rods lapped sufficiently with the rods of adjacent beam to develop their full working compressive strength.

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* Chief Engineer, Simpson Bros. Corporation, Boston.

It seems to me that this is the only place where compression steel can be used economically or practically, and it is not necessary to use it here, as the concrete can be increased in section by haunching the beam so that the full compression can be resisted by it alone.

Concrete is a flexible material, and may be subject to many variations in design. It is also subject to mechanical difficulties of handling which may not be readily apparent in the design. Steel is not as economical in compression as is concrete, and the richer the concrete, the more economical it is. Therefore it is not desirable to reinforce with steel the upper portion of a concrete beam to obtain additional strength. In the first place, with the beam loaded up with 2.13 per cent. of steel, you have nearly all the steel you can conveniently place concrete around and still properly spade it, without any additional compression and tension steel. In the second place, a 1 : 2 : 4 concrete is general up to the limit allowable for shear or diagonal tension with the maximum of 2.13 per cent. of tension steel. In the third place, if it is absolutely necessary to get additional strength with a limited section, use a richer concrete in the beams and in the necessary width of flange, for which the maximum value of P may be assumed at 2.70 per cent. for a 1 : $1\frac{1}{2}$: 3 concrete, or 3.20 per cent. for a 1 : 1 : 2 concrete. You will find that this will give all the steel you can mechanically take care of. Fourth, provided you have a thin slab combined with a deep beam or girder, it is often desirable to thicken up the slab at the intersection with beams to obtain larger compression area of concrete.

Without any criticism of Mr. Lorente's able and interesting paper I wish to emphasize my personal views that it is not necessary or wise at this time to put out formulæ dissenting from or varying slightly from the Joint Committee's recommendations, and thus further muddling the brains of the engineer who has occasion to use reinforced concrete sections in his every-day work and has not the time to work out intricate formulæ or reconcile variations in different theories, and that there is no necessity for compressive steel in the upper side of concrete beams.

While figures do not lie, and the results obtained are always the same, using the same figures in the same way, nevertheless the actual results obtained in building concrete members will vary to a certain extent, as there is an allowable variation in strength of concrete between prescribed limits. There is a variation in modulus of elasticity of concrete, a slight variation in the moment arm, which for convenience is assumed generally as $\frac{7}{8}$ *d*, so that in considering formulæ which only technically differ, we are actually putting ourselves in the same position as the man who wishes to obtain a certain measurement approximately, and paces it off, and then measures the last few inches with a tape so that it may be accurate.

MR. M. J. LORENTE (*by letter*). — The author wishes to join Mr. J. R. Worcester in his commendation of Messrs. Clifford and Mangold's method of dealing with beams with steel in compression. He would like to point out, however, that there is no fair comparison between their and his own methods.

Messrs. Clifford and Mangold's method is useful in reviewing a beam, i. e., in finding the stresses in a given section, with a given amount of steel. But for designing a beam, i. e., finding the amount of steel necessary in a section, their method is of the hit-or-miss variety, whereas the author's will give the exact amount at the first trial and with little trouble.

Considering that such eminent engineers as Messrs. Worcester and Andrews have entirely misunderstood the paper, perhaps there is some truth in Mr. Worcester's statement that the paper is " almost unintelligible." The author, nevertheless, is of the opinion that any paper is unintelligible, no matter how much intelligence the writer may have put into its writing, if the reader refuses to use his own intelligence in the reading of it.

The omissions which Mr. Worcester complains of were deliberately made because the author bore in mind the fact that he was not addressing a class at a technical school but a society of civil engineers. The formulæ whose notation was not explained are of such an extremely elementary nature that no engineer worthy of the name should fail to recognize them at first sight.

Mr. Worcester seems to be under the impression that the location of the neutral axis of a beam section is fixed. Now, the location of the neutral axis of a beam, being absolutely independent of the shape or material of the section, can be anywhere. If we make $\frac{f_s}{n} = f_c$, the neutral axis will be equidistant from the top of the beam and the center of the steel. If $\frac{f_s}{n}$ be considerably larger than f_c, the neutral axis will be near the top of the beam. Again, if $\frac{f_s}{n}$ be considerably smaller than f_c, the neutral axis will be quite close to the steel. In the section in question, the stress in the concrete of the imaginary areas subtracted is the same as that in the concrete at the bottom of the slab in the T-beam, and, as the stress in the steel is the same for both the T and the sections subtracted, the neutral axis of the latter must of necessity coincide with the neutral axis of the former, so that, taking them separately, the neutral axis of the whole is the neutral axis of each part. That the two coincide is not a mere caprice of the author but a mathematical eventuality without which the method would be an utter impossibility.

Mr. Worcester's statement that " the whole paper is limited in application to beams with balanced reinforcement, that is, with just enough steel to produce simultaneously the desired stresses in both concrete and steel " is absolutely unwarranted, except by a complete failure to grasp the author's method. Supposing we had a bending moment of 2 188 000 in.-lbs. and that considerations of shear and head room limited the size of the beam to a width of 14 in. and an effective depth of 25 in. Suppose further that the thickness of the slab be 6 in. By the author's method, we would find that the area of steel required would be 5.47 sq. in. Even if we could get a combination of bars that would give us the required steel area, the beam would not be balanced because the width of T required would be only 30 in., yet we could, if other considerations permitted it, use at least 60 in., for the slab is 6 in. thick. Such a beam is far from being a balanced beam, yet it is a perfectly practical one, similar to thousands that are being designed daily, and it can be obtained by following the author's method. The fact of the matter is that the author's method is not limited at all and may be applied to any T-beam whatsoever.

Mr. Worcester again has missed the point in regard to beams with steel in compression. Messrs. Clifford and Mangold's method may be " much more useful and concise," but neither could be replaced by the other. As already explained, the author's method will give a design at the first trial. The other method will not, unless by mere chance, for that method is for reviewing, not for designing, a beam.

Mr. Andrews unnecessarily takes up the cudgels in favor of the Joint Committee, for the author did not make any attack upon them. In fact, all his assumptions have been sanctioned by the Committee. So that, not only are the results obtained by the author's method " not so very different from the recommendations of the Committee," but they are bound to be exactly alike.

What the author has done is to use his mathematics in a different way, so as to facilitate the design, for, as Mr. Andrews says, the Joint Committee's report " is not in practical shape for use by the designer."

The author fully sympathizes with Mr. Andrews in his wish to standardize concrete beams, but, should Mr. Andrews undertake the task and live long enough to accomplish it, he would be sure to break the record for longevity. For, whereas steel beams are limited in shape and stresses, concrete beams are susceptible, within practical limits, of endless changes.

As to steel in the compression side of a beam, the author again disagrees with Mr. Andrews. Steel may not be as economical as concrete, but economy is not always the ruling factor in design. Other considerations far more important very often compel the use of steel in compression. Thus the author could point out to Mr. Andrews hundreds of beams, built in Boston and neighborhood, from the designs of very competent engineers and with the approval of men of eminence in the profession, where the use of steel in compression could not have been avoided.

The use of haunches in beams can seldom be resorted to, for, as a rule, the architect objects to them. Besides, it is doubtful whether the saving in steel would compensate for the extra expense in complicated form work and in detailing.

Apart altogether from the fact that the author did not say or advocate anything in his paper against the Joint Committee, he would like to point out to Mr. Andrews that the Joint Committee is just as fallible as all human institutions are liable to be. He should remember that the Committee is not formed by the only eminent engineers on earth but by only an extremely small number of them. And he should not forget that some of the members of the original committee, just as eminent as those in the present body, very forcibly dissented in a minority report from the findings of their colleagues. So that the report is the expression of opinion of a very limited number of engineers, and it is rather a pity that men like Mr. Andrews should attribute to that report a finality to which the Committee itself laid no claim.

The report of the Joint Committee is only a "progress report" which has already undergone some modifications and will, no doubt, suffer a good many more in years to come. And it could not be otherwise, for the reports are founded on the theories, experiments and works of a host of toilers who are constantly striving for something better. The report is, in fact, a record of the work done in the field of reinforced concrete, and even as a record it is considerably behind date, as there is still no mention of flat slabs in it. Would Mr. Andrews advocate that no such slabs be built and that no investigations be made, simply because the Joint Committee say nothing about them?

If independent thinkers and observers should cease their labors because the Joint Committee has issued a report, then the Committee would become a victim to paralysis from want of something to do, and *ipse facto* would cease to exist.

The author's opinion is that we all should do our share in the advancement of engineering science, hoping that the Joint Committee will some day recognize our labors before its usefulness has passed.

MEMOIRS OF DECEASED MEMBERS.

THEODORE LOUIS KEPPLER.*

THE subject of this sketch was probably one of the least known to the membership of the Boston Society of Civil Engineers, and one of the best loved of men by the few who came in contact with him. His extremely courteous, hospitable and modest manner instantly charmed not only those whom he met casually, but also his hundreds of employees. Such a man was Theodore Louis Keppler, who was born at Stuttgart, Würtemberg, Germany, November 28, 1847.

His schooling was limited, for, at the age of sixteen, he went to sea, and during the next few years he traveled over a considerable portion of the world, at one time acting as mate of a vessel. With the tide setting toward America just after the Civil War, he landed in Boston in 1867, and, walking up a street near the wharf at which he had just landed, was so insistent in being put to work by almost the first merchant he accosted, that he was promptly hired, and remained for some months at the occupation, now passed into oblivion, of painting scenery on window screens, at which Mr. Keppler rather excelled. But tiring of this kind of work he soon found employment in the Union Sugar Refinery at Liberty Square, in Charlestown. He was here from 1868 to 1871, when he went to the Standard Sugar Refinery at South Boston on Granite Street, and remained there up to the day of his death.

His long career in one establishment rather contradicted the idea that a man must needs shift employers to avoid stagnation. Mr. Keppler rose by successive steps to the position of assistant superintendent, which position he held up to 1895, when, on the death of Mr. John H. Webster, a member of the Boston Society of Civil Engineers, he was made superintendent, holding this position at the time of his death, so that he was in the employ of the Standard Sugar Refinery for forty-four years.

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* Memoir prepared by Frederic I. Winslow.

Mr. Keppler became an associate member of the Boston Society of Civil Engineers February 16, 1910, and although rarely seen at the meetings of the Society he appreciated them highly, and on one occasion entertained the members at the refinery in a manner which lingered long in the minds of those who were present. He was a man of almost no vacations, and was at the works every day without exception for many years. He was the soul of geniality, extremely generous-hearted, and although a very busy man, could always find time to be helpful to others. The immediate cause of his death, which occurred at his home in Brookline on May 24, 1915, was pneumonia. He leaves a widow, a brother and a sister, the two latter residing in Germany.

Mr. Keppler was a member of the Algonquin Club, the Merchants Club, the Boston Chamber of Commerce, the Engineers Club, Order of Odd Fellows, the Maugus Club of Wellesley, the Hull Yacht Club, Deutsche Gesellschaft and a number of philanthropic societies.

LEVI GOWEN HAWKES.*

Levi Gowen Hawkes, one of the older members of this Society, was stricken with paralysis while at work in his office in October, 1914, and died on the 8th of November of the same year.

Mr. Hawkes was born in Saugus, Mass., April 14, 1851. He was the son of Louis P. and Mary A. (Gowen) Hawkes, the oldest of seven children, and a direct descendant of Adam Hawkes, one of the first settlers of the town. His early studies were in the local public schools. At fourteen he attended a private school in Lynn and at sixteen he entered the Friends' Boarding School at Providence, R. I., where he remained two years, making a record as a keen and painstaking student. Later he studied civil engineering in Boston, under Professor

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* Memoir prepared by James E. Stone, Theodore P. Perkins and Edward P. Adams.

Watson, and thereafter was engaged in engineering work for the Boston & Providence Railroad Company and other steam and street railway companies in Massachusetts, Rhode Island, Connecticut and New Jersey.

Mr. Hawkes became a member of the Society December 19, 1888, and made his home in Boston for a time, working on various engineering matters. Afterward he opened an office in his native town and there remained, building up a reputation as a competent engineer and surveyor, and establishing himself as an authority on the lines and bounds of a large number of estates in Saugus and the surrounding towns. In 1897 he married Ida F. Chandler, of Lynn, who survives him.

Mr. Hawkes was a quiet man, of a genial disposition, a great reader along literary and scientific lines, fond of gardening, and devoted to his home and his town, in which he held the office of assessor for nine years and that of trustee of the public library for a long period. He was upright, regular and methodical in business and social affairs, and greatly respected by his neighbors and associates.

WALTER JENNEY.*

Walter Jenney was born in South Boston, February 7, 1856, and died May 8, 1915. He was the son of Bernard Jenney and Mary F. Coney Jenney, who were early settlers and had always been identified with South Boston affairs. His father was born in Boston on the site of the present building at Milk and Oliver streets, and is still living at the age of eighty-eight years.

He graduated from the Bigelow Grammar School and then entered the English High School, from which he graduated in 1872. Shortly after this he entered the Massachusetts Institute of Technology, graduating with the class of '77 in the course of mining engineering, which at that time embraced a large amount of chemical research and investigations. During his course at the Institute he was prominent in many of the student activities, which, however, were much less than at the present day. His military experience in the English High School was of value in military affairs at the Institute, and he was appointed captain of one of the companies of the battalion, which at that time was under the command of Lieutenant Zalinski, U. S. A., at that time detailed as military instructor to the Institute. During this period Jenney was one of a committee of '77 who selected the Institute colors of cardinal red and silver gray which were eventually adopted permanently. During his entire course he set high ideals in his studies and conduct and with his genial manner was much beloved by his classmates and professors.

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* Memoir prepared by Richard A. Hale and Arthur L. Plimpton.

Immediately after graduation he took a position with the Jenney Manufacturing Company as superintendent. This company, of which his father, Bernard Jenney, is president, is engaged in the refining of petroleum, manufacturing of light oils, etc., and is one of the largest concerns in eastern United States.

His technical training and methods of investigation and research enabled him to solve many difficult problems that were constantly arising, and the results have been shown in the successful career which the company has had. In 1900 he was made vice-president and general manager, but still retained his close connection with various details of the business. Notwithstanding his close attention to business he interested himself in public affairs and was a member of the Trade Association of South Boston and served as second vice-president for several years. He took an active part in the agitation for the industrial improvement of the district for better street car service and all civic improvements tending to better conditions.

He was a member of the South Boston Savings Bank and had served for many years on the Board of Investment. He was a member of the Boston Society of Civil Engineers and kept himself informed of technical progress in various lines with which he was connected. He belonged to the Boston City Club, the common meeting ground of many of his business friends and acquaintances. He was also a member of the Masonic fraternity.

He married, June 30, 1880, Elizabeth Bowers Hedge, of

South Boston, who survives him, together with four sons, Herbert H., Charles S., Walter H., and Malcolm. One son, Henry Hedge, died in 1883.

The home life and associations with the large family about him was thoroughly appreciated. He was very musical and was for many years an active member of the Handel and Haydn Association, a good pianist and also church organist, at times substituting for the regular organist at the church which he attended.

He enjoyed nature and outdoor life and was very familiar with the New Hampshire mountains, having made many tramping trips during his summer vacations, and taken many photographs of the scenery.

He was a charter member of the Appalachian Mountain Club and for two years had served as president and held the office at the time of his death. He was a lifelong member of the Hawes Unitarian Church and a constant attendant at services and earnest in matters connected with the parish. He had been chairman of the standing committee of the church for twenty-five years and also chairman of the music committee.

His earnestness and faithful attention to important duties in all his work have shown a strong character that will leave a lasting impression with all with whom he came in contact.

He died of pneumonia after an illness of six weeks, during which time he appeared to be improving, and it was thought that the crisis was past. A change came suddenly and he failed rapidly, passing away quietly Monday, May 8. The last services were held in the Hawes Unitarian Church, which was filled with relatives and friends and representatives from various organizations to which he belonged.

Interment was in Forest Hills Cemetery.

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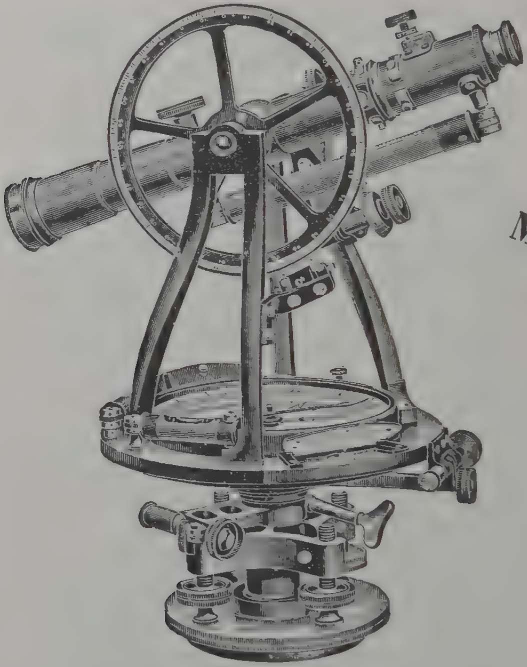

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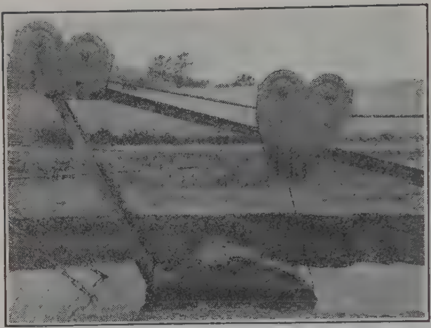

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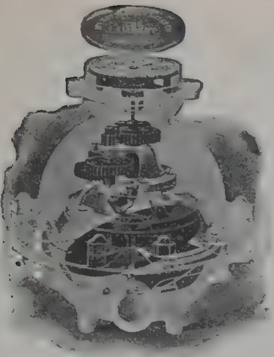

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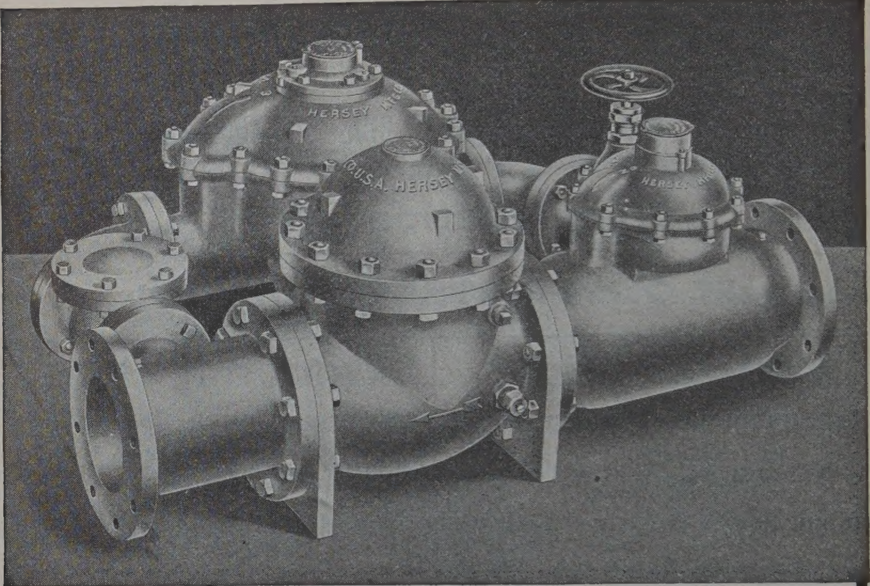

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